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(71) Applicant: TELEFONAKTIEBOLAGET LM ERICSSON (publ) [SE/SE]; S-126 25 Stockholm (SE).

(72) Inventor: LUPIEN, Francis; 4708 Jeanne Mance, Montreal, Quebec H2V 4J4 (CA).

(74) Agent: ERICSSON RADIO SYSTEMS AB; Patent Unit Radio Access, S-164 80 Stockholm (SE).

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(54) Title: TELECOMMUNICATIONS NETWORK INTEGRATING CELLULAR, PACKET-SWITCHED, AND VOICE-OVER-IP INFRASTRUCTURES

(57) Abstract: A telecommunications network (100) that integrates infrastructures from the Plain Old Cellular System (POCS)(998), Packet-Switched Networks (PSN), and Voice-over-IP (VoIP) networks (999) such as those based on the H.323 protocol or the Session Initiation Protocol (SIP). The integrated network (100) supports VoIP mobile terminals as well as legacy mobile terminals operating through VoIP proxies (132 and 144) which act as clients to make legacy mobile terminals appear as IP terminals to VoIP servers in the network. The VoIP proxies may be implemented in the base station (140), in an intermediate Radio Access Network (RAN)(130), or in the terminal itself (142) (making the terminal a VoIP terminal) in which case no proxy is needed in the network. The proxies and VoIP terminals support both the native POCS and the native VoIP signaling and functionality. A Mobile VoIP Call Control Server (MVoIPCCS) (118) fuses native POCS call-service functions, Wireless Intelligent Network (WIN) service functions, and native PSN/VoIP session/call control functions to create a super-set of session/call control functions. Integrated mobility handling functionality is provided by a generalized Visitor Location Register (VLR)(124) that fuses legacy POCS ANSI-41 VLR functions, SIP location server functions, and H.323 location management functions. POCS authentication functions are integrated with PSN/VoIP security functions. Teleservices and resource management functions are also integrated.

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TELECOMMUNICATIONS NETWORK INTEGRATING CELLULAR, PACKET-SWITCHED, AND VOICE-OVER-IP INFRASTRUCTURES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application discloses subject matter related to the subject matter disclosed in the following co-assigned patent applications:

(1) "System and Method for Providing Wireless Telephony over a Packet-Switched Network," filed October 26, 1999, Ser. No. 09/427,508, in the names of: Kim Phuc Vo, George Foti, Hung Tran, Jean-Francois Bertrand, Bartosz Balazinski, Francis Lupien, Zeng-Jun Xiang, and Yang Lu;

(2) "System and Method for Providing Mobile Switching and Multi-Party Services over a Packet-Switched Network," filed October 26, 1999, Ser. No. 09/426,513, in the names of: Hung Tran, Bartosz Balazinski, Jean-Francois Bertrand, and Laura Hernandez.; and

(3) "System and Method for Mobile Terminal Registration in an Integrated Wireless Packet-Switched Network," filed October 26, 1999, Ser. No. 09/427,471, in the names of: Hung Tran, Laura Hernandez, Jean-Francois Bertrand, and Bartosz Balazinski.

BACKGROUND OF THE INVENTION

Technical Field of the Invention

The present invention relates to telecommunication systems and, more particularly, to an integrated telecommunications network which includes a cellular network portion and a packet-switched network (PSN) such as, for example, a network using the Internet Protocol (IP).

Description of Related Art

Coupled with the phenomenal growth in popularity of the Internet, there has been a tremendous interest in using packet-switched network (PSN) infrastructures (e.g., those based on IP addressing) as a replacement for the existing circuit-switched network (CSN) infrastructures used in today's telephony. From the network

operators' perspective, the inherent traffic aggregation in packet-switched infrastructures allows for a reduction in the cost of transmission and the infrastructure cost per end-user. Ultimately, such cost reductions enable the network operators to pass on the concomitant cost savings to the end-users.

The existing Voice-over-IP (VoIP) networks implement communications infrastructures that are typically based on multiple protocols which include, for example, the well-known H.323 protocol. These protocols are primarily oriented to operating with fixed-network-based telecommunications protocols and are designed to provide such services as call control, et cetera, for wireline subscribers. Current VoIP systems, accordingly, cannot be used advantageously in wireless environments, although some VoIP systems may support rudimentary location management services.

There exist several inadequacies in the Plain Old Cellular System (POCS) with respect to supporting IP-based infrastructures and services. Also, there exist deficiencies and shortcomings in the existing IP-based VoIP systems in terms of supporting wireless access technology such as for example, ANSI-136, Global System for Mobile communications (GSM), IS-95, et cetera. Some of the more significant of these inadequacies and shortcomings are summarized below.

First, current POCS systems and technological infrastructures are not compatible with communications infrastructures as required by the VoIP standards. The operation, maintenance, and the connection management required by the traditional POCS systems are based on switched physical trunk connections. These mechanisms are not compatible with the packet switching/routing mechanisms such as, e.g., the Domain Name System (DNS), Dynamic Host Configuration Protocol (DHCP), et cetera, required for managing device/host addressing and configuration.

Incompatibilities also exist between POCS protocols and communications protocols of the existing VoIP applications. The POCS infrastructures cannot support a Plain Old Telephone System (POTS) or Integrated Services Digital Network (ISDN) client in the Internet context. The Internet "client" is typically required to handle Internet-based protocols such as, e.g., Real-time Transfer Protocol (RTP), Resource Reservation Protocol (RSVP), et cetera, which are not in the definition or domain of the POCS infrastructures.

Another important disparity which should be noted is that the POCS signaling and user data planes use distinct physical transport and network facilities, whereas the same physical network facilities are used to route signaling and user data information in the Internet domain. Furthermore, the IP-based networks can support any higher layer protocols, and can be transported over any lower layer, e.g., a link layer and/or physical layer. In addition, the higher layer protocols may be used for signaling and/or user data.

With respect to the inadequacies of the existing VoIP systems, it should be appreciated that current VoIP clients and infrastructures can handle neither the wireless access-side technology nor the basic network-side functional signaling plane which enables mobility management, authentication/security, service definition, service mitigation and execution, et cetera. Clearly, the provision of such advancements in the POCS as Wireless Intelligent Network (WIN) services, can only magnify these and other disparities and incompatibilities between the POCS and VoIP infrastructures.

Based on the foregoing, it is apparent that in order to address these and other problems of the current technologies set forth above, what is needed is a seamless integration between the existing POCS and VoIP infrastructures so that the numerous advantages, known and hitherto unknown, of packet-based networks may be realized within the context of wireless telecommunications. The present invention provides such a solution.

SUMMARY OF THE INVENTION

The present invention is directed to a telecommunications network that integrates infrastructures from the Plain Old Cellular System (POCS), Packet-Switched Networks (PSN), and Voice-over-IP (VoIP) networks such as those based on the H.323 protocol from the International Telecommunications Union (ITU) or Session Initiation Protocol (SIP) from the Internet Engineering Task Force (IETF). The integrated network ("wireless IP" or "WLIP" network) supports VoIP mobile terminals as well as legacy mobile terminals operating through VoIP proxies. The VoIP proxies act as clients which make legacy mobile terminals appear as IP terminals

to VoIP servers in the network. The VoIP proxies may be implemented in the base station, in an intermediate Radio Access Network (RAN), or in the terminal itself (making the terminal a VoIP terminal) in which case no proxy is needed in the network. The proxies and VoIP terminals support both the native POCS and the native VoIP signaling and functionality.

The native POCS basic call-service functions and Wireless Intelligent Network (WIN) service-processing functions are integrated with the native PSN/VoIP session/call control functions (SIP/H.323) in a unified configuration. A call control server called the Mobile VoIP Call Control Server (MVoIPCCS) is created to fuse these operations, creating a super-set of session/call control functions. This provides an integrated telecommunications network having all the call, session, and service characteristics of a POCS/PSN/VoIP system. This provides the basis of a more generic multi-media (MM) call control server entity.

Integrated mobility handling functionality is provided by a generalized Visitor Location Register (VLR). The VLR fuses legacy POCS ANSI-41 VLR functions, SIP location server functions, and H.323 location management functions in a super-set of mobility functions. In addition, ANSI-41 authentication functions are performed in an Authentication Center (AC) with interwork through the ANSI-41 Public Land Mobile Network (PLMN) to the POCS/PSN/VoIP integrated network. If required and needed, PSN/VoIP security is provided by the POCS/PSN/VoIP integrated network.

One or more legacy POCS networks may be interfaced with the POCS/PSN/VoIP integrated network through a Mobility Gateway (MGW). The MGW may be located at the border between the PLMN and the POCS/PSN/VoIP integrated network.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the present invention may be had by reference to the following Detailed Description when taken in conjunction with the accompanying drawings wherein:

FIG. 1 depicts an architectural view of a conventional network arrangement provided with separate cellular and packet-switched portions; and

FIG. 2 depicts a functional block diagram of a presently preferred exemplary embodiment of an integrated network ("wireless IP" or "WLIP" network) which combines POCS and IP infrastructures in accordance with the teachings of the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

As set forth above, the present invention is broadly directed to providing an integrated telecommunications network which combines the existing POCS network infrastructures with a packet-switched network for the purpose of transmitting cellular communications/data using, at least in part, appropriate packet data transmission protocols. In a presently preferred exemplary embodiment, the integrated network system of the present invention is envisaged as a wireless Internet Protocol (WLIP) network system.

FIG. 1 depicts an architectural view of a conventional network arrangement which includes separate and independent cellular and packet-switched portions. The cellular portion includes the POCS infrastructure portion 998 that is associated with one or more conventional base stations, e.g., BS 150A and BS 150B, providing radio access. A plurality of mobile stations (MSs), e.g., MS 142A and MS 142B, are disposed in a typical air-interface arrangement with the base stations. A conventional packet-switched VoIP portion 999 is coupled to a Public Switched Telephone Network (PSTN) 102 via a PSTN gateway 997 in a conventional manner.

Referring now to FIG. 2, the overall architectural scheme underlying the WLIP network system of the present invention is designed to provide inter-operable functionality among several entities, some new and some legacy, such as for example, an ANSI-41 Public Land Mobile Network (PLMN) portion, a PSTN portion, a new (enhanced) VoIP network portion, and a new (enhanced) ANSI-136 Radio Access Network (RAN). Further, new (enhanced) cellular infrastructures are advantageously modified such that the benefits of IP-based switching are maximized.

The Wireless IP (WLIP) network of the present invention integrates infrastructures from POCS, PSN, and VoIP networks such as H.323 or SIP. The POCS/PSN/VoIP integrated network supports both VoIP mobile terminals and legacy

mobile terminals through VoIP proxies. The VoIP proxies act as clients which make legacy mobile terminals appear as IP terminals to VoIP servers in the network. In the network, the VoIP proxies may be implemented in the base station or in an intermediate RAN. Alternatively, proxies may be implemented the terminals themselves, in which case no proxy is needed in the network. The proxies and VoIP terminals support both the POCS and the VoIP native signaling and functions.

The native POCS basic call service functions and WIN service processing functions are integrated with the native PSN/VoIP session/call control functions in a unified configuration. The POCS transport infrastructures are mapped to PSN transport infrastructures. The POCS signaling plane in the serving part of the integrated POCS-PSN VoIP network portion 104 is replaced by the H.323 or SIP client/server model: VoIP proxy/terminal to server in the network, with the H.323/SIP signaling being enhanced with POCS features. The associated mobility handling protocol between the mobility-location server and its peer is preferably based on an enhanced or optimized H.323 or SIP location management signaling plane for carrying the ANSI-136-specific registration signaling information. This signaling plane preferably re-uses the H.323 or SIP registration signaling wherever or whenever feasible. Otherwise, it should be readily understood by those of ordinary skill in the art that additional primitives may be appropriately added with respect to this objective.

The POCS signaling plane in the network part (ANSI-41 only) has been mapped on a different transport (IP). The POCS data plane has been replaced by a client/client model (VoIP proxy/terminal to Media Gateway/VoIP client in the PDN such as in H.323/SIP) in the new POCS-PSN VoIP network portion 104. The remaining POCS infrastructure (or circuit-switched portion) includes the signaling and transport of the mobile terminal-to-base station legacy air interface (i.e., when a VoIP proxy is in the BS or the RAN).

The Mobile VoIP Call Control Server (MVoIPCCS) fuses the native POCS basic call service functions and WIN service processing functions with the native PSN/VoIP session/call control functions to create a super-set of session/call control functions. This provides an integrated telecommunications network having all the call, session, and service characteristics of a POCS,/PSN/VoIP system. This provides

the basis of a more generic multi-media (MM) call control server entity.

Integrated mobility handling functionality is provided by a generalized VLR which fuses legacy POCS ANSI-41 VLR functions, SIP location server functions, and H.323 location management functions in a super-set of mobility functions. In addition, ANSI-41 authentication functions are performed in the AC with interwork through the ANSI-41 PLMN to the WLIP network. If required and needed, PSN-VoIP security is provided by the WLIP network.

One or more legacy POCS networks may be interfaced with the POCS/PSN/VoIP integrated network through a Mobility Gateway (MGW). The MGW may be located at the border between the PLMN and the POCS/PSN/VoIP integrated network.

In order to provide a better understanding of the WLIP architectural scheme of the present invention, the functional sub-architectures of the conventional POCS and VoIP network portions are first described briefly hereinbelow.

The description herein discusses the POCS signaling plane and associated functions in terms of ANSI-136/41, but it would be understood by those skilled in the art that the POCS signaling plane and associated functions may also be based on IS-95 technology, or other appropriate radio telecommunications standards. The POCS signaling plane and associated functions can be defined by the following high level components:

- a Radio Access Network (RAN) control component;
- Switching resources with associated management functions and connection control functions;
- mobility management, authentication, and security functions;
- call and service processing control; and
- Wireless Intelligent Network (WIN) service processing functions, if applicable.

The VoIP sub-architectures can be defined by utilizing the following high level components:

- a "telephony" call client (typically, the user) for call originating/terminating
- a "telephony" call server (typically, the network, e.g., a VoIP network) to

handle connection control and associated signaling for setting up, and maintaining connections between (a) the PSTN portion and VoIP call client; and (b) two VoIP call clients;

- a location directory and associated location services for maintaining the location of IP devices such as ports, et cetera; and

- a media gateway interfacing with the call server for connection control and other PSTN and PLMN control signaling, and with the call client for user data transport and exchange.

In the interest of maximizing the IP-based switching benefits while maintaining the integrity of both ANSI-136/41 and VoIP architectural components, what may be deemed as a selective vertical integration approach is utilized in implementing the WLIP architectural scheme of the present invention. Accordingly, in the vertical integration model, selective POCS and VoIP functionalities may preferably be combined into one or more functional units that can operate with either types of standards or protocols. Further, relationships may be advantageously defined between functional components that belong to different network realms (e.g., POCS or VoIP realms), where they perform similar and/or related tasks.

Therefore, in the context of the present patent application, the selective vertical integration approach involves maintaining the ANSI-136/41 signaling plane as independent as possible from the VoIP functional plane, while providing components that implement both functional planes, such as the VoIP proxy, MVoIPCCS, location server, etc.

To replace or augment the circuit-switched infrastructures of the POCS network portion with the packet-switched VoIP portion, the ANSI-41/136 network portions are provided with the VoIP proxy interface for managing call control, mobility, and services. It should be appreciated that the closer the VoIP proxy is provided to the radio access point, the more optimal is the IP transport utilization. Accordingly, the VoIP proxy devices are directly interfaced with the ANSI-136 RAN portions of the integrated architectural WLIP scheme.

FIG. 2 is a functional block diagram of a presently preferred exemplary embodiment of an integrated telecommunications network (WLIP network) 100

provided in accordance with the teachings of the present invention. The POCS sub-architectures with respect to the WLIP architectural scheme are in their enhanced formats described above, and are provided as a composite of a plurality of enhanced network portions. A first network portion 114 comprises a plurality of enhanced cellular components such as, for example, an Authentication Center (AC) 156, a Message Center (MC) 158, a Home Location Register (HLR) 160, a Service Control Point (SCP) 162, et cetera. Preferably, a Signaling System 7 (SS7)-to-IP interface component 164 may also be provided therewith. An ANSI-41 signaling path 166A (provided on an IP-based path instead of SS7) connects the enhanced POCS network portion 114 with a gateway network portion 112. Additionally, an ANSI-41 path 166B is provided between the enhanced POCS network portion 114 and the PSTN/PLMN 102 in a conventional manner.

The gateway network portion 112 may preferably be provided as a sub-network through which inter-network communications between circuit-switched portions and packet-switched portions may be routed. The gateway portion provides for inter-network communication for ANSI-41 POCS signaling using the IP transport discussed above. One or more media gateways, for example, gateway (GW) 152, are preferably provided as part of the network portion 112 for this purpose. A mobility gateway (MGW) 154 may also be provided as part of this network portion for the purpose of implementing a mobility management entity that maintains the MS-associated VoIP infrastructure location information. In accordance with the teachings of the present invention, the MGW is preferably provided as a protocol converter for the specified signaling between the ANSI-41 and PSN VoIP infrastructures. From the MGW's perspective, and from the perspective of the POCS network, the VoIP infrastructure location server/directory is hierarchically at a lower level (that is, the VoIP infrastructure location server/directory is slave to the MGW). In this sense, the MGW is seen as a VLR by the ANSI-41 PLMN.

An ANSI-41 path 167 is provided between the MGW and the ANSI-41 PLMN 102. The MGW handles the ANSI-41 automatic roaming signaling interface for location management towards the ANSI-41 network (i.e., a subset of the D interface). It also implements the PSN-specific location management signaling interface to/from

the PSN infrastructure (i.e., RAS, SIP signaling, et cetera).

When seen as an entity having VLR-like functionality, the MGW handles the call routing signaling interface for routing of calls between ANSI-41 PLMN and PSN VoIP networks. Towards the ANSI-41 PLMN, the MGW handles automatic roaming signaling interface for call delivery (that is, location requests, route requests, etc.). On the PSN side, the MGW handles the VoIP call routing interface, e.g., an H.323 or SIP call routing interface. It should be readily appreciated that this mechanism enables the routing of calls and services from the ANSI-41 PLMN towards the served PSN VoIP system.

Optionally, the MGW may implement the ANSI-41 C interface and be utilized as a "mobile routing gateway" by the PSN for calls originating in the PSN and destined for the ANSI-41 PLMN. It should be noted, however, that the PSN-originated calls may also be routed through a regular media gateway (e.g., the media gateway 152), depending on the routing case chosen.

Continuing to refer to FIG. 2, to facilitate the inter-network communications, a plurality of paths are provided between the gateway network portion 112 and the other network portions of the WLIP network system 100. For example, an ANSI-41 signaling path 166A (provided on an IP-based path instead of SS7) connects the POCS network portion 114 with the gateway network portion 112. An ISDN User Part (ISUP) path 168 is available for providing connectivity between the PSTN/PLMN portion 102 and the gateway network portion 112. Also, depending upon the protocol requirements of the actual implementation of the VoIP network portion of the integrated POCS-PSN VoIP network portion 104, a suitable IP-based path 169 may be provided between the gateway network portion 112 and the VoIP network portion. Path 166A and 169 both carry ANSI-41 signaling and enable the POCS network portion 114 to exchange ANSI-41 signaling through the gateway network portion 112 with the integrated POCS-PSN VoIP network portion 104. A Packet Data Network (PDN) 106 of the PSN type is also connected to the gateway network portion 112 in accordance herewith.

When referring to components or portions of the integrated POCS-PSN VoIP network portion 104, it should be understood that the names given the components

refer to the new (enhanced) versions, and not the legacy components of the same name.

The VoIP portion of the integrated POCS and VoIP network portion 104 may be implemented using any known technologies and standards, or combinations thereof such as, for example, the well-known H.323 protocol by the International Telecommunications Union (ITU), Session Initiation Protocol (SIP) or Internet Protocol Device Control (IPDC) by the Internet Engineering Task Force (IETF), or Simple Gateway Control Protocol (SGCP). Regardless of the actual protocol implementation, the VoIP network portion 104 may preferably be provided as a plurality of interconnected hub, bridges or routers, such as, for example, hub/bridge element 103. Using multiple hub/bridge elements, sub-portions may be effectuated within the integrated VoIP network portion 104, wherein each sub-portion may be realized in, or optimized for, a different VoIP protocol or standard. For example, an H.323 sub-portion (comprising an IP core) 206 is exemplified in FIG. 2, which can include elements such as, e.g., gatekeepers and endpoints. In addition to the H.323 IP core 206, a plurality of components such as, for example, an Exchange Terminal (ET) 116, a Subscriber Services Function (SSF) component 122, a Special Resources (SR) component 126, et cetera, may preferably be provided within the integrated VoIP network portion 104. The SSF component 122 may be optimized for Intelligent Network (IN) services. Preferably, an SS7-to-IP interface component 128 may also be provided therewith.

Still continuing to refer to FIG. 2, in accordance with the teachings of the present invention, the POCS basic call and service processing control is implemented as an IP infrastructure, for example, within a VoIP call server. This component, referred to as the Mobile VoIP Call Control Server (MVoIPCCS) 118, is also preferably provided as an element of the integrated VoIP network portion 104. The MVoIPCCS fuses the legacy POCS and legacy VoIP protocols, and hence is a generic call server. Furthermore, in some implementations, mobility gateway functionality may also be optionally integrated within the MVoIPCCS 118. The MVoIPCCS functionality is preferably designed to integrate the VoIP protocol and the applicable cellular protocol. The profile information used for a cellular subscriber to define the

services is preferably mapped into the MVoIPCCS server and the services are queued as the profile dictates. Also, in a different embodiment, mobility management may be provided as a separate IP-compatible element in the form of a VLR-like database 124. It should be appreciated that because at least a portion of the POCS functional entities are preferably implemented on IP infrastructures, the IP-based path 169 between the VoIP network portion 104 and the gateway network portion 112 is provided as a multi-protocol path usable with ANSI-41, User Agent Server (UAS), and User Agent Client (UAC) control messages, in addition to IP-based (e.g., H.323) messaging. Additionally, an ANSI-41/ISUP path 170 is provided between the integrated POCS-PSN VoIP network portion 104 and the PSTN/PLMN 102.

In accordance with the teachings of the present invention, the RAN functionality may be provided as one or more transport network portions for radio access. In the exemplary embodiment of the WLIP network 100 of FIG. 2, a first RAN network portion 108A and a second RAN network portion 108B are depicted wherein each network portion preferably comprises one or more radio network controller (RNC) components, for example, RNC 130A and RNC 130B, in addition to a plurality of base stations (BSs). The RNC is a server which includes functionality that would otherwise be implemented in a legacy Mobile Switching Center (MSC) to provide ANSI-136 radio resource control and management functionality. The BSs of the RAN network portions may comprise legacy components, e.g., BS 150A through BS 150D.

Furthermore, the RAN network portions, which may preferably be provided as operator-controlled intranets (e.g., IP-based intranets), also include base stations that are integrated with a VoIP proxy device 144, e.g., BS 140A through BS 140D. It should be readily realized that by maintaining the VoIP proxy (which emulates the image of an IP terminal and operates as a VoIP call client, *inter alia*) at the base stations, the beneficial features of IP-based transport and switching may be maximized for cellular communications because of transmission savings due to the IP multiplexing that occurs as close as possible to the traffic source.

Preferably, an RNC of the RAN network portions is implemented as the server of a client-server architecture for interfacing with the call controlling entity in the

integrated VoIP network, that is, the MVoIPCCS call server. This interface conveys information related to the allocation and management of radio resources and radio connection management functional procedures for call setup and handoff, respectively.

A plurality of mobile terminals (MTs) or stations (MSs), e.g., MS 142A - MS 142C, are disposed in the ANSI-136 air interface relationship with the BSs. The RNCs maintain a peer-to-peer relationship with their MSs for radio-related communications such as radio connection management, which may encompass MS assignment of radio channel for call setup and handoff, supervision of the radio path (i.e., channel) used by an MS etc.

For providing the VoIP call client functionality with respect to the BSs that are not integrated with the VoIP proxy component, one or more separate VoIP proxy components may also be provided within the transport network portions. For example, stand-alone VoIP proxy components 132A and 132B are shown in FIG. 2. In addition, although not shown in FIG. 2, it should be appreciated that the VoIP proxy functionality may be provided in the MT itself, in which case there may be no need to provide the proxy functionality as separate components elsewhere in the WLIP network 100. Accordingly, in some exemplary embodiments, the VoIP proxy component 144 at the base station level may be regarded as a first interworking interface module, whereas a VoIP proxy component disposed on the RNC intranet network portion (e.g., VoIP proxy 132B) may be regarded as a second interworking interface module within the context of the present invention.

As explained above, the VoIP network portion of the integrated POCS-PSN VoIP network portion 104 is preferably provided as a plurality of interconnected hub, bridges or routers, such as, for example, the hub/bridge element 103, and using these hub/bridge elements, sub-portions may be effectuated within the VoIP network portion, wherein each sub-portion may be realized in, or optimized for, a different VoIP protocol or standard. For example, in addition to the H.323 IP core portion 206 depicted in FIG. 1, a SIP sub-portion may also be provided therein (not shown). Such a SIP sub-portion may comprise elements such as, for example, SIP Proxy servers, one or more SIP clients, User Agent Servers (UAS) and User Agent Clients (UAC), a Location Directory and Location Server, one or more SIP servers, et cetera.

A detailed functional description of the integrated WLIP network 100 will now be set forth below.

As stated in the foregoing, the ANSI-136/41 signaling plane and functions are selectively vertically integrated within the VoIP system functional plane. Accordingly, the radio access and transport network portions are maintained by integrating the VoIP proxy functionality at three functional levels (e.g., sub-network portion level, base station level, and MT level) as described above. The VoIP proxies are introduced in such a manner as to maximize IP transport to support legacy terminals when new POCS-PSN VoIP networks are deployed. The mobility management services are also integrated in such a manner as to maximize IP transport and switching for cellular traffic. From the perspective of the core network (i.e., all but the RAN), the ANSI-41 network infrastructure's mobility management functions and the native VoIP infrastructure's location server/directory functions may preferably be united as to form one functional entity called as "mobility-location server". Preferably, the mobility-location server may be provided as a VLR-like database (e.g., "VLR" 124) and may be implemented in one physical component. In alternative embodiments, the mobility-location server functionality may be comprised of distributed components within the integrated POCS-PSN VoIP network 104.

The mobility-location server provides consistent location information regarding the MS to both ANSI-41 PLMN and VoIP-based PSN portions (e.g., H.323 cores, SIP networks etc.). This provision allows for voice calls to be delivered to the served MS when the calls originate from either the ANSI-41 PLMN or a remote VoIP PSN facility. Further, the mobility gateway functionality as described hereinabove which connects the functional nodes and signaling of the ANSI-41 PLMN with the VoIP control infrastructures (i.e., gatekeepers, call servers, location servers, etc.) can also be integrated as a sub-unit within the mobility-location server. Alternatively, the MGW can be placed external to such mobility-location server. In a further alternative embodiment, the MGW functionality may be provided as part of the MVoIPCCS functionality, which may be distributed among various nodes/sub-networks of the integrated VoIP network.

The associated mobility handling protocol between the mobility-location

server and its peer is preferably based on an enhanced or optimized H.323 or SIP location management signaling plane for carrying the ANSI-136-specific registration signaling information. This signaling plane preferably re-uses the H.323 or SIP registration signaling wherever or whenever feasible. Otherwise, it should be readily understood by those of ordinary skill in the art that additional primitives may be appropriately added with respect to this objective.

The mobile terminal's peer component to the mobility functions implements the ANSI-136-specific native signaling. Accordingly, suitable protocol adaptation may preferably be performed between the MT and the integrated mobility-location server unit. Therefore, a "mobility proxy" is provided within the RAN portion for performing the requisite protocol adaptation towards the POCS-PSN VoIP integrated network 104. The mobility proxy part of the VoIP proxy is equivalent to the mobility client proxy that performs adaptation toward the associated server at the integrated POCS-PSN VoIP network. The mobility proxy may be referred to as a registration client for the VoIP portion of the WLIP network system 100. The mobility client preferably updates location information towards the mobility-location server of the POCS-PSN VoIP integrated network 104.

From the perspective of the VoIP network portion, calls generated from the IP domain may be delivered to the ANSI-136 MTs via the media GW 152 or routed directly through the VoIP infrastructures. In order to facilitate the routing of calls through the VoIP infrastructures, such infrastructures are provided with the mobility management functions that are compatible the ANSI-41 network reference model and infrastructure.

Call and service processing control is also combined using a selective vertical integration approach. From the core network's perspective, the POCS and PSN call control and basic services functions are integrated within a functional entity. A new call server (such as, e.g., the MVoIPCCS 118) is provided which may be implemented in one physical component or in distributed components within the integrated POCS-PSN VoIP network. The call server preferably provides consistent call control services to legacy MTs and MTs with a VoIP proxy terminal, which may roam in service areas where VoIP services such as H.323/SIP may be provided in the access

network. It should be realized by those of ordinary skill in the art that the selective vertical integration provided in accordance herewith enhances the current H.323/SIP call processing functionality so as to converge to a richer set of functions. Also, it allows the POCS call processing to be enhanced by the PSN protocols (e.g., Q.931). Moreover, the vertical integration approach allows one to introduce the POCS way of handling services in the context of mobility with an interface towards the VoIP portions of the WLIP network.

The associated call control protocol between the MVoIPCCS server and its peer is preferably based on an optimized H.323 call control signaling or SIP UAS-UAC signaling. The signaling plane, preferably enhanced for carrying ANSI-136/41-specific signaling information, may re-use the H.323/SIP signaling whenever feasible. Otherwise, a suitable set of additional primitives need to be incorporated.

Since the MT's peer implements ANSI-136 native call control signaling, a protocol adaptation scheme is implemented between the MT and the integrated call server (MVoIPCCS)-based protocol. A "call control proxy" part of the VoIP proxy performs protocol adaptation toward the associated server at the integrated POCS-PSN VoIP network. This call control proxy part may be referred to as a call control client for the VoIP portion of the WLIP network.

Calls from the PLMN are preferably routed through an interrogating integrated structure provided within the integrated POCS-PSN VoIP network, which is provided to indicate the appropriate location for call delivery, including locations in the IP domain, to/through the VoIP infrastructures. From the perspective of the VoIP network infrastructure, it is not precluded that calls to ANSI-136 devices may originate in the PSN/IP domain. Such calls are delivered transparently by routing either to the POCS-PSN infrastructure through the media gateway, or directly through the VoIP infrastructure based on existing inter-VoIP network protocols.

Call and service processing control relating to Intelligent Network (e.g., a Wireless Intelligent Network or WIN) functions are handled through the integrated POCS-PSN VoIP network components. For example, WIN call and service processing is preferably effectuated by implementing a functional interface between the MVoIPCCS 118 and the SSF component 122 of the integrated POCS-PSN VoIP

network 104. A new signaling plane is introduced to implement the requirement of this functional interface. Preferably, the functional interface is defined by the requirement that MS WIN detection points (DPs) or triggers are stored in the SSF and are delivered through mobility management procedures such as profile updates. In order to effectuate triggering, the MVoIPCCS implements an associated interface to poll the SSF for each call event in the MVoIPCCS. Alternatively, the SSF may be integrated within the MVoIPCCS wherein the interface is not required.

In addition, the MVoIPCCS may also implement a functional interface to the SR component 126 to control the integrated POCS-PSN VoIP network components. Typically, the SR component may be provided as an intelligent peripheral. This signaling plane is introduced for implementing the requirement of the functional interface which allows the SR to be located anywhere within the integrated POCS-PSN VoIP network. The SSF 122 can also control the SR component, depending on the meaning associated with a specific detection point, for realization of WIN call processing and service processing.

With respect to inter-system handoff, the VoIP client is preferably maintained within the new serving system. The VoIP proxy states are transferred to the new serving system through inter-system handoff procedures. A component is provided within the integrated POCS-PSN VoIP network for coordinating this function.

Also, a new inter-RAN protocol is implemented between the RAN portions in order to carry out the transfer of states. For this purpose, the MVoIPCCS component 118 receives a handover order from the associated RNC. Based on the location information from the serving RAN's RNC, the MVoIPCCS orders the new target RAN, through its RNC, to allocate a channel. The target RAN also receives the address of the serving VoIP proxy. Thereafter, the target RAN allocates a VoIP proxy.

The VoIP proxy interrogates the serving RAN VoIP proxy for state (call, mobility, et cetera) information. Once this process is successful, the MVoIPCCS is ready to order the RNC to send a handoff order to the MS. Subsequently, after receiving the handoff order, the MS tunes to the indicated channel and resumes voice traffic.

The integrated WLIP network 100 of the present invention also incorporates

various other legacy ANSI-136/41 functions such as, e.g., authentication, teleservices, et cetera, in addition to miscellaneous IP-specific functions, e.g., security protocols over H.323 or SIP realizations. Accordingly, the ANSI-136 access network and ANSI-41 core network (i.e, the PSN-enhanced ANSI-41 network or the legacy ANSI-41 PLMN) of the POCS network portions provide access, global challenge and other authentication directives, whereas the integrated VoIP network portion 104 provides the security functions for the IP terminals.

Therefore, from the core network perspective, the ANSI-41 network's security functions are handled by a separate functional entity in the integrated POCS-PSN VoIP network. A new server may be implemented in one physical component, or in distributed components within the integrated POCS-PSN VoIP network. Since the MT's peer component to the ANSI-41 security functions implements ANSI-136 native signaling, a protocol adaptation needs to be performed between the MT and the integrated ANSI-41 security server within the integrated POCS-PSN VoIP network. In order to support the security server-based authentication signaling components within the integrated POCS-PSN VoIP network, a functional "security proxy" is located within the RAN portion to perform the requisite protocol adaptation towards thereto. This security proxy may be referred to as an ANSI-136 security client for the VoIP portion(s) of the WLIP network 100, whose protocol is based on ANSI-41 and ANSI-136 signaling.

Further, in accordance with the teachings of the present invention, independent of the ANSI-136, the security functions prevailing in the IP-based infrastructures such as Authentication and Authorization may also be carried at access between an MS IP security client and the associated server(s) in the integrated POCS-PSN VoIP network. The client preferably supports the Internet security components for IP signaling, VoIP signaling and user data towards the integrated POCS-PSN VoIP network and associated Authentication, Authorization and Accounting (AAA) server and security gateway. The client-server protocol is preferably based on native H.323 and SIP IP security signaling.

In addition, POCS legacy 136/41 teleservices functions may be realized within the integrated POCS-PSN VoIP network. An MS is preferably provided access to

ANSI-41/ANSI-136 teleservices, message waiting indication (MWI), and other miscellaneous MS directives including miscellaneous signaling. From the core network' perspective, these functions are handled by separate functional entity or entities in the integrated POCS-PSN VoIP network. A new server is preferably implemented in one physical component, or in distributed components within the integrated POCS-PSN VoIP network. Since the MT's peer component to these ANSI-41 functions implements ANSI-136 native signaling, once again a protocol adaptation is performed between the MT and the integrated server within the integrated POCS-PSN VoIP network. Once again, in order to support these signaling components in the integrated POCS-PSN VoIP network, a functional 136 proxy is provided within the RAN portion for performing the protocol adaptation. The following clients may be introduced as proxy for VoIP: ANSI-136 teleservice client and ANSI-136 non-call associated signaling client, whose protocol is preferably based on ANSI-41 and ANSI-136 legacy signaling.

It should be appreciated that other client-server signaling and proxy functions are handled within the RAN portion without any interaction with the ANSI-41 servers. These functions are preferably related to the local administration of policies such as resource management, bandwidth allocation and Quality of Services (QoS) for admission control in relation to RAS protocol within H.323 and RSVP/IETF protocol etc. Similarly, a proxy is implemented in the RAN portion to support the signaling plane for admission control and resource reservation, which may be referred to as an admission control client for the VoIP portions of the WLIP network 100.

Based on the foregoing, it should be appreciated that the present invention advantageously provides an integrated telecommunications network that incorporates the existing cellular elements and IP-based protocols into a seamless vertically integrated infrastructure for transporting cellular traffic over a packet-switched network. Further, by providing the interworking interface modules (VoIP proxy devices) at multiple levels within the cellular infrastructures, legacy mobile terminals and base stations may continue to be utilized within the WLIP architecture of the present invention. Furthermore, the constituent components of the VoIP proxy devices, namely, a mobility client, ANSI-136 authentication and security client, ANSI-

136 teleservice client, ANSI-136 non-call associated signaling client, one or more admission control clients for VoIP, a call control client, etc. described hereinabove, and the functionality of the MVoIPCCS, mobility-location server and the MGW, may be combined and/or distributed in various permutations and combinations within/throughout the WLIP network at different levels, thereby giving rise to extraordinary flexibility in implementation and optimization.

Although the present invention has been described in particular reference to the H.323 protocol and ANSI-41/136 standards, it should be realized upon reference hereto that the innovative teachings contained herein are not necessarily limited thereto and may be implemented advantageously with any applicable PSN-IP protocols and radio telecommunications standards.

Further, it is believed that the operation and construction of the present invention will be apparent from the foregoing detailed description. While the embodiments shown and described have been characterized as being preferred, it will be readily apparent that various changes and modifications could be made therein without departing from the scope of the present invention as set forth in the following claims.

WHAT IS CLAIMED IS:

1. A telecommunications network that integrates infrastructures from the Plain Old Cellular System (POCS), Packet-Switched Networks (PSN), and Voice-over-Internet Protocol (VoIP) networks to provide Wireless IP (WLIP) services to non-IP (legacy) mobile terminals and to VoIP-capable mobile terminals, said network comprising:

a plurality of base stations serving both legacy mobile terminals and VoIP mobile terminals operating in the integrated network, at least one of said base stations having a VoIP proxy for interfacing legacy mobile terminals to the network;

a Radio Access Network (RAN) portion connecting the base stations to the integrated network, said RAN including at least one VoIP proxy for interfacing legacy mobile terminals to the network when the legacy mobile terminals are being served by a base station that does not include a VoIP proxy;

a Mobile VoIP Call Control Server (MVoIPCCS) that creates a super-set of session/call control functions for use by VoIP proxy clients by integrating in a unified configuration, native POCS basic call-service functions and Wireless Intelligent Network (WIN) service-processing functions with native PSN/VoIP session/call control functions;

a mobility-location server that creates a super-set of mobility functions for use by VoIP proxy clients by integrating legacy POCS VLR functions, and IP-based location server functions and location management functions; and

a security server that performs POCS authentication functions and PSN and VoIP security functions in the integrated network.

2. The telecommunications network of claim 1 further comprising a mobility gateway operating as a protocol converter between the POCS infrastructure and the PSN/VoIP infrastructures, said mobility gateway connecting functional nodes in the Public Land Mobile Network (PLMN) with VoIP control infrastructures.

3. The telecommunications network of claim 2 wherein the mobility

gateway is implemented in the mobility-location server.

4. The telecommunications network of claim 2 wherein the mobility gateway is implemented in the MVoIPCCS.

5. The telecommunications network of claim 2 wherein the mobility gateway is implemented as a stand-alone entity in the integrated network.

6. The telecommunications network of claim 2 wherein the mobility-location server communicates with the mobility gateway using an H.323 location management signaling plane that is enhanced to carry POCS-specific registration signaling information.

7. The telecommunications network of claim 2 wherein the mobility-location server communicates with the mobility gateway using a SIP location management signaling plane that is enhanced to carry POCS-specific registration signaling information.

8. The telecommunications network of claim 1 wherein the RAN also includes a registration client that performs protocol adaptation and sends registration location information from mobile terminals to the mobility-location server.

9. The telecommunications network of claim 8 wherein the MVoIPCCS communicates with clients in the network using an H.323 call-control signaling plane that is enhanced to carry POCS-specific call-control signaling information.

10. The telecommunications network of claim 8 wherein the MVoIPCCS communicates with clients in the network using a SIP User Agent Servers (UAS) and User Agent Clients (UAC) call-control signaling plane that is enhanced to carry POCS-specific call-control signaling information.

11. The telecommunications network of claim 1 wherein the RAN also includes a call-control client that performs protocol adaptation and sends call-control information from mobile terminals to the MVoIPCCS.

12. The telecommunications network of claim 1 wherein the security server is an Authentication Center (AC) that performs POCS authentication functions and interworks with PSN and VoIP security functions in the integrated network.

13. The telecommunications network of claim 1 wherein the RAN also includes a security proxy performing protocol adaptation between mobile terminals and the security server.

14. The telecommunications network of claim 13 wherein the security proxy is an ANSI-136 security client in a network in which the POCS infrastructure is based on ANSI-136.

15. The telecommunications network of claim 1 further comprising a Subscriber Services Function (SSF) that stores WIN detection points and interfaces with the MVoIPCCS to implement WIN services in the integrated network.

16. The telecommunications network of claim 15 wherein the MVoIPCCS utilizes a functional interface to poll the SSF for each call event in the MVoIPCCS.

17. The telecommunications network of claim 1 wherein the MVoIPCCS includes a Subscriber Services Function (SSF) that stores WIN detection points utilized with call events in the MVoIPCCS to implement WIN services in the integrated network.

18. The telecommunications network of claim 17 further comprising a Special Resources (SR) component, said SR component being an intelligent peripheral that is controlled by the SSF when required for a specific WIN detection point.

19. The telecommunications network of claim 1 further comprising a Special Resources (SR) component, said SR component being an intelligent peripheral that is controlled through a functional interface by the MVoIPCCS.

20. The telecommunications network of claim 1 wherein the network includes a plurality of RANs, and an inter-system handoff is performed between a first RAN and a second RAN by transferring VoIP proxy states from the first RAN to the second RAN utilizing an inter-RAN protocol.

21. The telecommunications network of claim 20 wherein each RAN includes a Radio Network Controller (RNC), and the RNC associated with the first RAN sends a handoff order and mobile terminal location information to the MVoIPCCS, the MVoIPCCS selects the second RAN based on the location information, and the RNC associated with the second RAN receives an order from the MVoIPCCS to allocate a channel.

22. The telecommunications network of claim 21 wherein the second RAN includes means for allocating a second RAN VoIP proxy which interrogates the first RAN VoIP proxy for state information.

23. The telecommunications network of claim 1 further comprising a teleservice server for implementing teleservices and handling non-call associated signaling in the integrated network.

24. The telecommunications network of claim 23 wherein the RAN also includes a teleservice client that performs protocol adaptation and sends teleservice information from mobile terminals to the teleservice server.

25. The telecommunications network of claim 24 wherein the RAN also includes a non-call signaling client that performs protocol adaptation and sends non-call associated signaling information from mobile terminals to the teleservice server.

26. The telecommunications network of claim 1 further comprising an admission control server for managing resources, allocating bandwidth, and monitoring Quality of Service (QoS) in the integrated network.

27. The telecommunications network of claim 26 wherein the RAN also includes an admission control client that performs protocol adaptation and sends resource, bandwidth, and QoS information from the RAN to the admission control server.

28. A telecommunications network comprising:

one or more base stations for effectuating radio communication with a plurality of mobile terminals;

one or more radio network controllers (RNCs) operably coupled to the base stations for controlling radio access services to the mobile terminals;

a call server disposed in an integrated Voice-over-IP (VoIP) network portion, wherein the call server is engaged in a server-client interfacing relationship with at least one of the RNCs, the RNC being the server, the call server providing call and service processing control with respect to the mobile terminals at least one of which is equipped with a VoIP terminal;

a mobility gateway connected to a cellular network portion and a packet-switched network portion, the mobility gateway operating as a protocol converter therebetween;

a mobility-location server providing mobility management functions of the cellular network portion and location server functions of the packet-switched network portion; and

a VoIP proxy device including a mobility client for interacting with the mobility-location server and a call control client for interacting with the call server, wherein the VoIP proxy device operates to perform protocol adaptation between a legacy cellular communication standard and a corresponding VoIP protocol.

29. The telecommunications network of claim 28 wherein the VoIP proxy

device is co-located with at least one of the base stations.

30. The telecommunications network of claim 28 wherein the RNCs are organized as an intranet operable with Internet Protocol and the VoIP proxy device is disposed on the RNC intranet.

31. The telecommunications network of claim 28 wherein the VoIP proxy device includes an ANSI-136 teleservices client and the integrated VoIP network portion includes a teleservices server.

32. The telecommunications network of claim 28 wherein the VoIP proxy device includes an ANSI-136 non-call associated signaling client and the and the integrated VoIP network portion includes a server therefor.

33. The telecommunications network of claim 28 wherein the VoIP proxy device includes an admission control client with respect to the packet-switched network portion.

34. The telecommunications network of claim 28 wherein the VoIP proxy device includes an authentication and security client and the integrated VoIP network portion includes a server therefor.

35. The telecommunications network of claim 28 wherein the mobility-location server and the mobility gateway are integrated and the mobility gateway operates to perform protocol conversion between ANSI-41 signaling and the H.323 protocol.

36. The telecommunications network of claim 28 wherein the mobility-location server and the mobility gateway are integrated and the mobility gateway operates to perform protocol conversion between ANSI-41 signaling and Session Initiation Protocol.

37. The telecommunications network of claim 28 wherein the call server and the mobility gateway are integrated and the mobility gateway operates to perform protocol conversion between ANSI-41 signaling and the H.323 protocol.

38. The telecommunications network of claim 28 wherein the call server and the mobility gateway are integrated and the mobility gateway operates to perform protocol conversion between ANSI-41 signaling and Session Initiation Protocol.

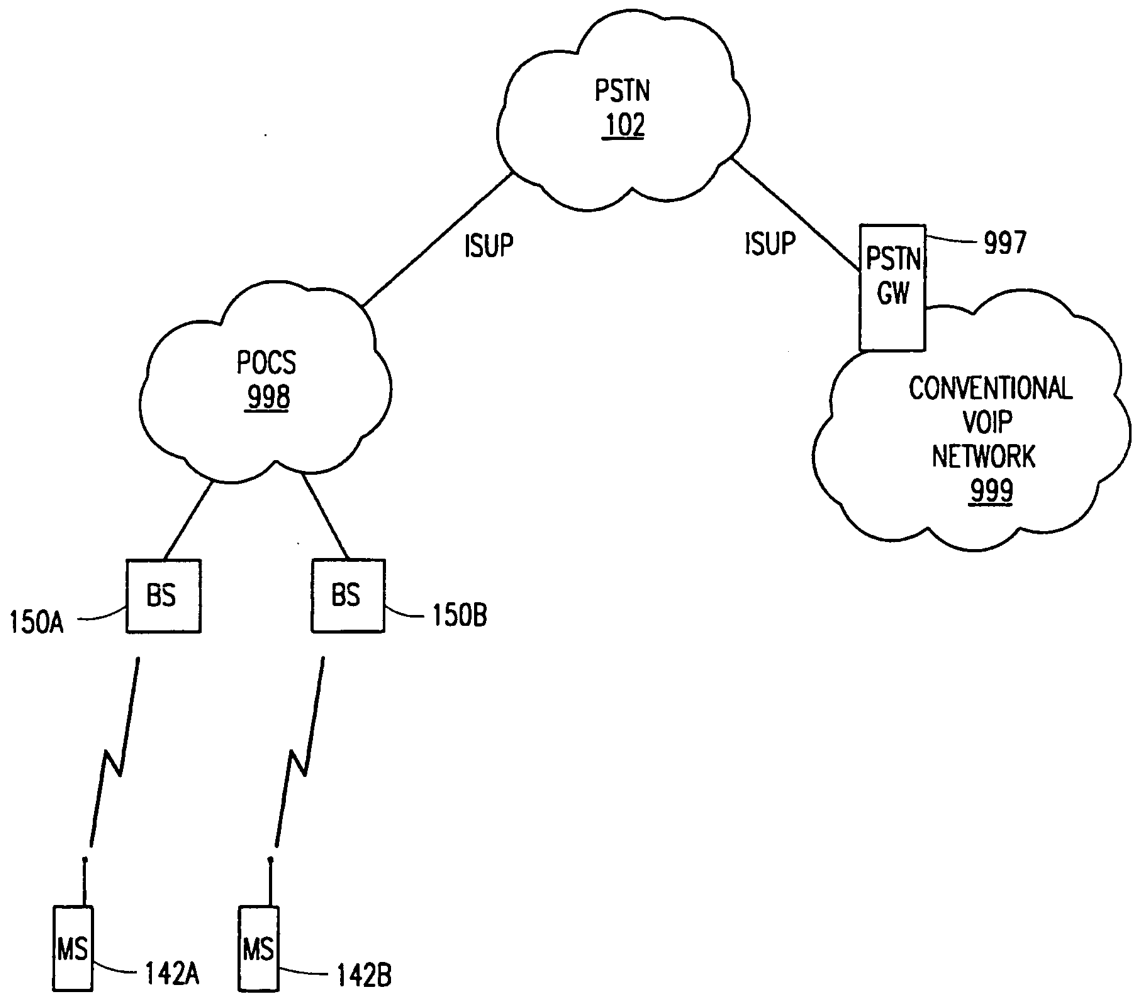

FIG. 1
(PRIOR ART)

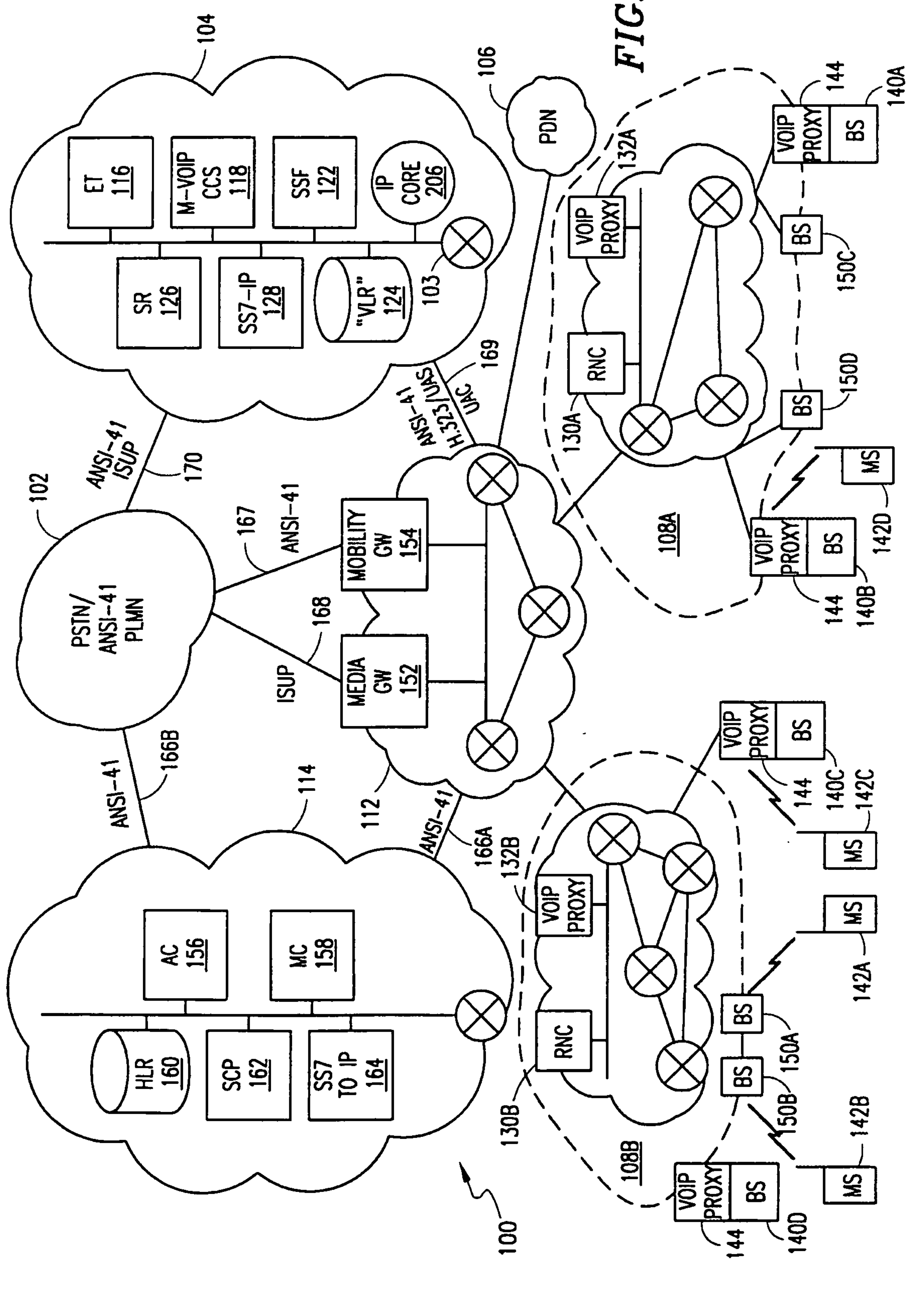
104
ET 116
M-VOIP CCS 118
SSF 122
IP CORE 206
SR 126
SS7-IP 128
"VLR" 124
103
106
PDN
102
PSTN/ ANSI-41 PLMN
ANSI-41 ISUP
170
167
ANSI-41
MOBILITY GW 154
168
ISUP
MEDIA GW 152
ANSI-41 H.323/UAS UAC
169
132A
VOIP PROXY
RNC
130A
BS
150C
150D
MS
108A
VOIP PROXY
BS
144
140A
140B
142D
ANSI-41
166B
114
112
ANSI-41
166A
132B
AC 156
MC 158
HLR 160
SCP 162
SS7 TO IP 164
RNC
130B
150A
150B
108B
140C
142C
142A
142B
140D
100

FIG. 2